TABLE 1.—*Solar radiation intensities during February, 1927*

Washington, D. C.

[Gram-calories per minute per square centimeter of normal surface]

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	1.0 [1]	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Feb. 2	3.99	0.69	0.79	0.98	1.25	1.57	1.17	0.96	0.89	0.80	3.81
7	4.17	0.62	0.70	0.87	1.07		1.10	0.82			4.17
10	4.75				1.08						4.37
11	3.63		0.73	0.94	1.22	1.64	1.28				2.16
17	7.29	0.85	0.97	1.08	1.32	1.62					5.79
26	5.36	0.77	0.89	1.04	1.26	1.52	1.26				2.49
Means		**0.73**	**0.82**	**0.98**	**1.20**	**1.59**	**1.20**	**(0.89)**	**(0.89)**	**(0.80)**	
Departures		**+0.02**	**+0.01**	**±0.00**	**+0.03**		**+0.01**	**−0.08**	**+0.05**	**+0.03**	

Madison, Wis.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Feb. 3	5.56				1.31		1.41	1.18			5.16
9	1.52						1.35				1.78
10	1.24	1.04	1.15	1.28	1.43						1.19
11	2.26				1.24			1.18			3.15
12	1.78	1.02	1.11	1.25	1.42	1.62					1.78
15	1.88			1.08							4.95
18	0.86				1.43		1.43	1.21			1.37
19	1.52		0.87	1.07	1.32		1.29				2.06
21	2.36			0.95	1.24						3.00
24	3.99			1.24	1.40	1.58	1.36				3.99
Means		**(1.03)**	**1.04**	**1.14**	**1.35**	**(1.60)**	**1.37**	**1.19**			
Departures		**+0.09**	**−0.07**	**−0.09**	**−0.02**		**+0.01**	**+0.01**			

Lincoln, Nebr.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Feb. 1	2.87	1.02	1.15	1.28	1.43	1.58					3.00
9	1.24						1.36		1.11	0.96	1.37
10	1.78		0.93	1.15	1.40		1.40	1.27	1.08	1.01	2.62
11	2.62			1.03	1.35			1.23	0.95		2.74
18	0.74	1.08	1.21	1.35	1.51	1.69	1.39	1.01	0.96	0.91	0.91
23	4.17		0.98	1.13	1.38		1.38	1.17	1.13	1.01	3.99
24	4.17						1.34				4.57
25	3.30	1.00	1.11	1.34	1.45	1.58					3.45
Means		**1.03**	**1.08**	**1.21**	**1.42**	**1.62**	**1.37**	**1.17**	**1.05**	**0.97**	
Departures		**+0.06**	**+0.03**	**+0.01**	**+0.04**		**+0.02**	**±0.00**	**+0.01**	**+0.05**	

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
1927	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 29	198	187	233	139	154	+6	−4	−4
Feb. 5	175	199	283	139	117	−32	−10	+20
12	186	200	243	127	119	−39	−32	−45
19	169	302	333	244	141	−78	+52	+23
Deficiency since first of year on Feb. 25						−1,687	−406	−553

PHOTOHELIOGRAPHIC OBSERVATIONS

[Communicated by Capt. EDWIN T. POLLOCK, Superintendent, United States Naval Observatory. Data furnished by the Naval Observatory in cooperation with Harvard, Yerkes, and Mount Wilson Observatories]

METHODS USED TO OBTAIN POSITIONS AND AREAS OF SUN SPOTS

UNITED STATES NAVAL OBSERVATORY, WASHINGTON, D. C.

The measured positions and areas of solar spots and groups herewith published were made from negatives taken with the 40-foot horizontal photoheliograph of the United States Naval Observatory. The 40-foot objective (12.192 m.) is of 5 inches (12.7 m.) aperture, corrected for actinic rays, and the solar image at the focus of the instrument is about 4¼ inches (10.8 cm.) in diameter. It is used in conjunction with an unsilvered plane mirror to throw the solar light in the proper direction. Photographs are taken daily near noon, weather permitting.

Dry plates 7 inches square are employed, coated with a slow lantern-slide emulsion, and are backed with a paste of Winsor and Newton moist lampblack before exposure, to prevent halation. Just in front of the photographic plate hangs a plumb line of fine wire which casts a sharp shadow image upon the solar disk during exposure. This exposure is made by a drop shutter with an adjustable slit located just in front of the plate. The vertical image of the plumb line impressed on the negative, together with the eastern standard time of exposure, furnish data for orientation of the plate.

An ingenious instrument recently devised by Mr. Watts and Miss Lamson, of the Naval Observatory, and constructed by the instrument maker at the observatory, was used for these measures.

Transparencies having the sun's outline and heliographic coordinates ruled for each 10°, corresponding to the period of observation, are used with this instrument. From these transparencies the heliographic latitudes and longitudes of the solar markings may be directly read, after setting for the proper position angle of the sun's axis at the time of observation. Areas to the nearest whole square degree are measured similarly, on a separate reticule line chart. Foreshortening is allowed for on this chart as the solar limb is approached, so that the true area is determined. Unless the larger spots comprising a group indicate individuality, the position measured is referred to the mean center of the group as a whole. With respect to position and area of spots, both umbra and penumbra are here considered as an entity. Faculæ are not included in these measures. For well defined objects not too near the limb these positions are probably accurate to ±0.5°.—*G. H. Peters.*

HARVARD COLLEGE OBSERVATORY

The solar image is photographed every clear day at the Harvard Astronomical Laboratory, using the Clark 8-inch equatorial with negative-enlarging lens to produce an equivalent focus of 553 centimeters, giving a solar image of about 6 centimeters diameter with a scale of 1 millimeter, representing about 14,500 miles or 24,000 kilometers near the center of the solar image. The telescope carries a special solar attachment for photographing the image, using a focal plane curtain shutter which may be adjusted in speed and opening to produce any exposure down to one-thousandth of a second. A color screen, selected to best suit the objective, was manufactured for us by the Eastman Kodak Co. The color curve of the lens was first determined and used as a basis for the selection of the proper filter. The filter is placed in the plate holder immediately in front of the plate. The objective is provided with a stop holder which makes possible the diminution of the light received on a clear day. An aperture of about 6 inches is used with an exposure of one five-hundredth of a second on a "Cramer contrast" plate.

The east and west line is located from the short dimension edge of the 4 by 5 inch plate, this being squared with the camera, which is carefully oriented by trails and clamped in place on the draw tube of the telescope.

The plates are developed in hydroquinone, and when fixed, dried, and labeled are ready for measurement. As the method of measuring x's and y's of the sun spots and reducing the same to the heliographic position by the usual trigonometrical computation is long and tedious and of greater accuracy than the nature of the problem seems to require or allow, a modification of the projective method devised by Hale and used at Yerkes and Mount Wilson has been adopted which has perhaps some merits as regards simplicity and convenience of operation.

In place of the steel ball used by Hale, we make use of a well-made white globe with celluloid finish, upon which marks can be made and erased with perfect satisfaction. The globe is 8 inches in diameter and is mounted in a supporting ring graduated into degrees. This supporting ring in turn is mounted in a fork support which may be adjusted about a vertical axis by the amount necessary to allow for the tip of the solar pole to or from the earth. The angle of inclination of the sun's axis to the fundamental plane perpendicular to the line of sight is taken from the Ephemeris, as is also the position angle of the solar axis with respect to the north and south line.

The adjustment of the axis of the globe for the latter inclination or position angle with the north and south line is effected by turning the supporting ring in the fork which supports it. The graduations on a horizontal circle facilitate the adjustment of tilt with respect to the fundamental plane, whereas the graduations of the supporting ring of the globe itself allow for accurate orientation of the axis in position angle.

When the globe has once had its axis adjusted to correspond to that of the sun for the day in question, the photographic negative is placed in the projecting lantern and the image of the negative solar disk cast upon the globe. The size of the image is made to exactly fit the globe by adjusting the distance of the globe from the lantern in conjunction with the focusing of the projecting lantern itself in the usual way. In this way compensation is provided for the change in the apparent diameter of the sun throughout the year.

With the solar image projected onto the globe the centers of all visible spots can be accurately located with a sharp-pointed pencil and numbered in any sequence or date desired. It is usually possible to mark on the globe the positions of spots from several negatives taken on successive days without confusion.

As soon as all the spots have been thus located for a given day or series of days, a solar meridian is carefully drawn along the edge of the brass supporting ring which will make possible the resetting of the globe to the same identical position or for any other longitude of sun's center that may be desired. The globe thus marked together with its supporting ring is then removed from the supporting stand and placed in a precision mounting accurately machined and with a horizontal circle reading by degrees from 0° to 360°. The globe and ring is placed in the stand so that the axis of the globe is perpendicular to the horizontal circle. The position of the pole is read directly from the brass supporting ring.

The globe is then rotated in its stand until each spot in turn is brought under the meridian ring from which the heliographic latitude is at once read directly to the nearest degree and by estimation to the nearest tenth of a degree. The difference in heliographic longitude is obtained at the same time by noting the movement of the fiduciary meridian with respect to the horizontal circle, reading again directly to the nearest degree and by estimation to the nearest tenth of a degree. The values published are referred to the meridian passing through the center of the sun's disk and are expressed to the nearest degree. By such an arrangement it is possible to make several independent set-ups and thus automatically check the determination of the position and reduce the probable errors of reading as desired.

It is sufficient to add that we have found such a method and arrangement greatly superior to the use of any of the several sets of sheets giving heliographic coordinate systems for certain limiting dates both as regards accuracy and facility in obtaining the desired data.

For determining the areas of spots, concerning which it is understood that areas in terms of the sun's hemisphere are desired, a plane metal disk is used in place of the globe as a projecting screen. This disk is covered with a sheet of coordinate paper, which has ruled upon it a circle 8 inches in diameter. The solar image is made to fill the 8-inch circle and the area of a spot is estimated in terms of the number of millimeter squares which are covered by the umbra and penumbra of the spot. These areas are then corrected for foreshortening by multiplying by the secant of the angular distance of the spot from the center of the disk, the corrected areas being then divided by the area of the hemisphere in square millimeters $\times 10^{-6}$ to give the actual area in millionths of the sun's hemisphere.

Experiments are in progress for the measurement of sun-spot areas by the use of a modification of the thermoelectric photometer,[1] but ways of eliminating or correcting for the varying background absorption have not yet been completely and satisfactorily worked out.—*H. T. Stetson.*

YERKES OBSERVATORY

At the Yerkes Observatory the direct photographs of the sun are taken with the 12-inch Kenwood equatorial diaphragmed down to an aperture of 3 inches. The focal length of the telescope is 5.49 meters, so that the solar image is about 51 millimeters in diameter. Sharp images are obtained with the lens, which is corrected for visual rays, by using a yellow filter and Eastman process plates. Short exposures are given by means of a plate shutter, operated by a spring, and reduced to a slit about 3 millimeters wide, over which the glass filter is fastened. The image was formerly oriented by means of the shadow of a metal wire stretched across the image of the sun; before the exposure the wire was oriented by projecting on it the image of the sun and examining on a ground glass to see if the wire was parallel to the diurnal motion of the sun's limb. Difficulty was encountered in keeping the metal wire perfectly straight. Since March 1, 1927, the orientation of the camera is obtained by using the edge of the shutter instead of a metal wire. This edge has been made exactly perpendicular to the direction of motion of the slit. A small opaque spot on the filter appears as a fine straight line on the negative, thus indicating the north-south direction.

For measuring the negatives they are projected by an arc lamp on the 6-inch graduated disks prepared by the Stonyhurst Observatory for that purpose. (Journal of the British Astronomical Association, vol. 18, p. 26, 1907.) The constants for the date determine the disk to be used and the rotation to be given to the negative so that one can read directly the latitudes, the differences of longitude between the spot and the central meridian, and also the areas in square degrees.—*George Van Biesbroeck.*

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[1] Astrophysical Journal 43:253:58:36.